Space Weather Technical Forecast

Issued on Saturday, 17 February 2024 at 12:47 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Decreasing chance of M-flares, and slight chance of X-flare. Slight chance of solar radiation storms, decreasing later.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate activity with peak flare M3.0 at 16/2209 UTC from AR3576 just over the southwest limb, and a number of C-class flares. This region continues to be the main risk for further flare activity, despite now retreating on the far-side with significant magnetic loops still evident on SDO imagery. There are nine Earth-sided sunspot regions, with the largest and most likely flare source of these being AR3583 in the northwest. This has ongoing flux emergence around its leader spot leading to the development of intermediate spots and increasing complexity. The other regions on the disc are all smaller and simpler

No Earth-directed CMEs were observed in this period, although a faint filament eruption from the southwest disc at around 17/0219 UTC has been assessed as both slow and likely passing south of Earth.

Solar Wind / Geomagnetic Activity: Solar winds as observed by ACE have been at background, at around 350 km/s, and these are supported by SOHO MTOF Proton Monitor, rather than the slightly elevated speeds observed by DSCOVR. Density was near or below average. Interplanetary Magnetic Field (IMF) Bt, was initially moderate at 7-10nT, but eased by 16/1750 UTC to be weak at 3-7nT. North-south component of the magnetic field, Bz, was initially moderately positive (northward) peaking +9nT but slowly eased with brief periods of negative (southward) with minimum -6 nT. Phi was initially mainly negative (towards the Sun) but switched to positive (away from the Sun) from 17/0100 UTC. Geomagnetic activity was Quiet (Kp 0 to 2).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux has been elevated above background levels but below the S1 Minor Solar Radiation Storm level, with peak 5.3pfu at 16/1205 UTC, and declining throughout. Electron flux (greater than 2MeV) has been at background levels, with electron fluence well below the Active (1e8 integrated pfu) threshold. The observed fluence at 17/0000UTC was 1.5e6 pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to Low activity is forecast, with an ongoing but decreasing chance of isolated M-flares. There remains a slight chance of an X-flare on day 1 (17 Feb), primarily from AR3576 which is now just over the southwest limb

Solar Wind / Geomagnetic Activity: Recent CMEs are expected to either miss or only have very minimal impact on Earth, with the most likely for an Earth-directed component being the filament eruption from the north-disc on 16 Feb, passing near Earth day 3-4 (19 Feb or early 20 Feb). No other significant solar wind enhancements feature in the period with mainly background winds expected. Geomagnetic activity is expected to be mostly Quiet through this period, perhaps becoming Unsettled with Active intervals with any CME arrival on days 3-4 (19-20 Feb).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux will continue to slowly decline towards background levels, but with a slight chance of further

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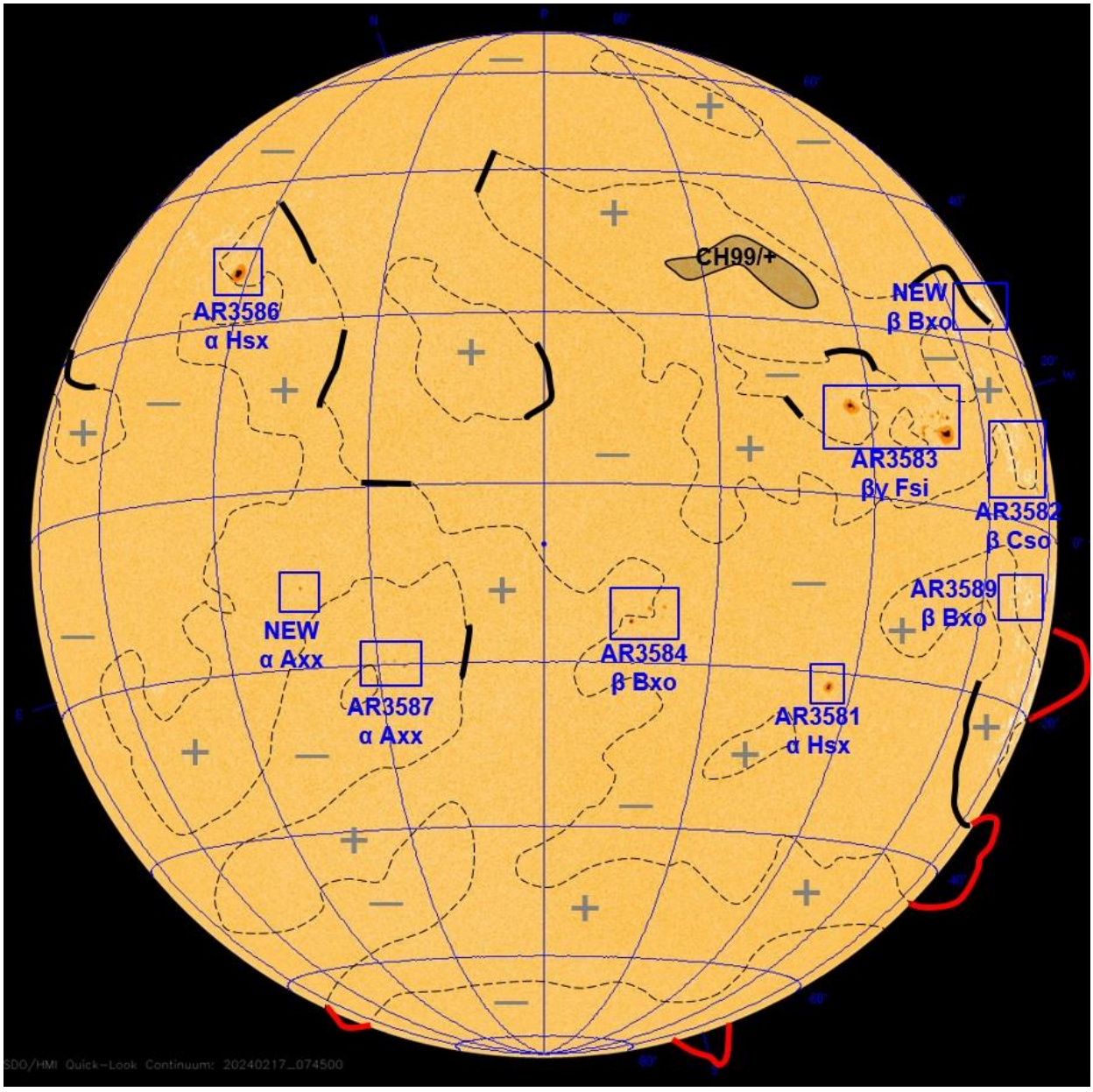
enhancement if any significant flares occur from either the regions on the west limb, or more likely from AR3576 just over the limb. Despite its far-side location this will continuing to bring a risk of solar radiation storms before receding further onto the far-side later in the period. High energy electron flux (greater than 2MeV) is expected to remain at background levels. The associated 24-hour electron fluence is expected to stay below the Active threshold.

Figure 1. Solar Analysis Valid 17/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one possible Earth-directed CME. This was a result of a filament eruption from the north centre disc. The majority of the ejecta is expected to travel north, above Earth's orbit, but with the potential for some glancing influence either day 3 (19 Feb) or early day 4 (20 Feb). The CME in association with the X2.5 flare from AR3576 is expected to will pass ahead of and below Earth's orbit.

No significant coronal holes are visible on the Earth-facing disc, with just a couple of very small and weak holes seen in imagery. In the absence of any CME arrivals, solar wind speeds are expected to remain near ambient or perhaps slightly elevated levels.

Geomagnetic activity is expected to be mostly Quiet through this period, perhaps becoming Unsettled with Active intervals with any CME arrival on days 3-4 (19-20 Feb).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
02/2232	Nil	Filament and C7 flare	NW	850 km/s	19/1600 +/- 12 hours	Likely missing, but chance of glancing impact

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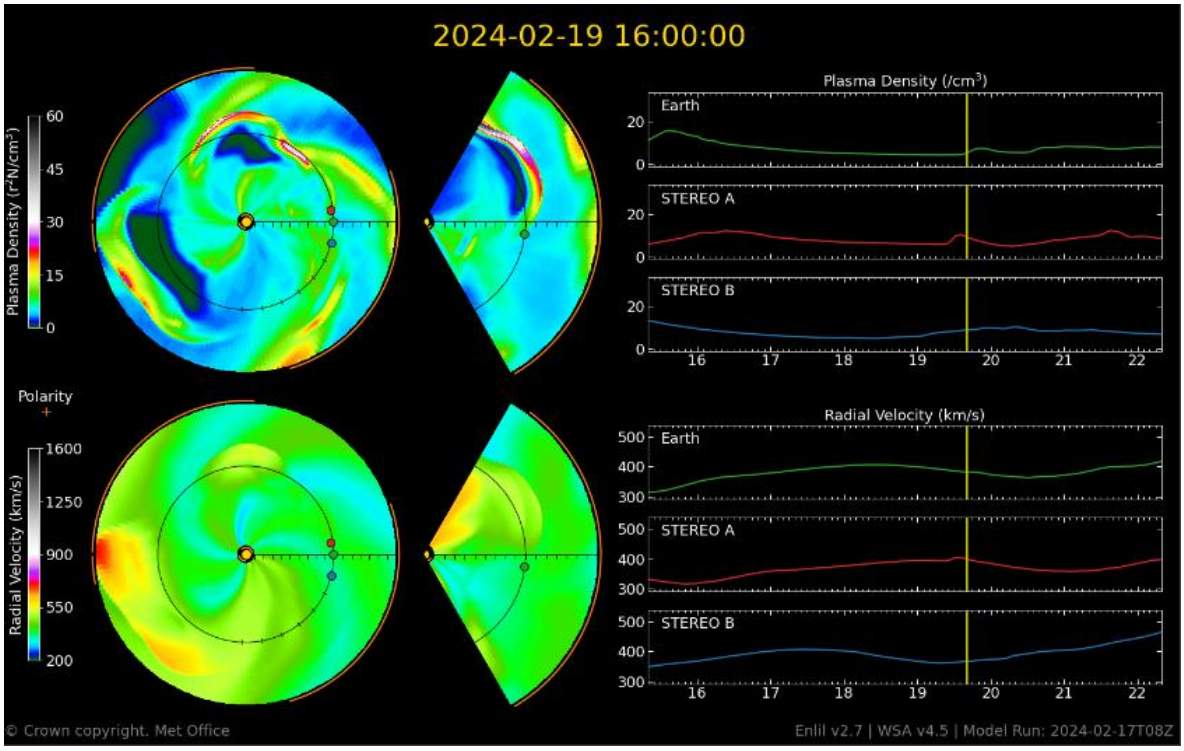
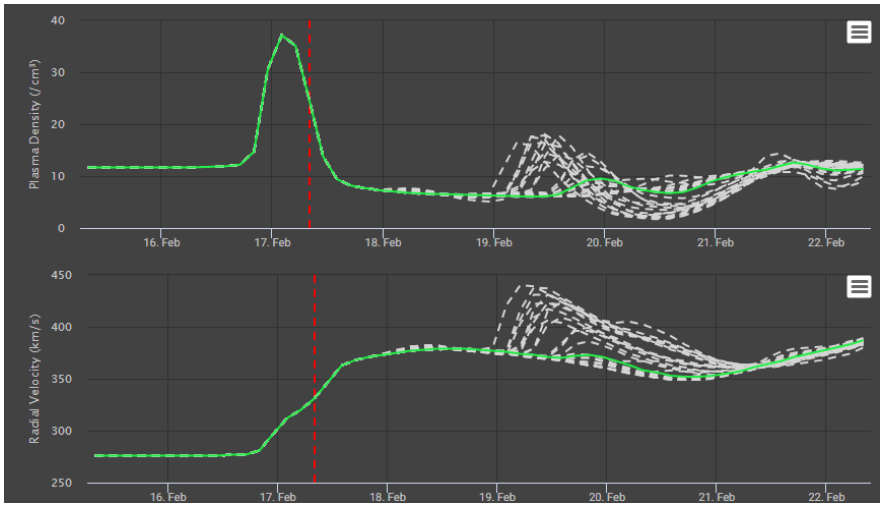
Figure 2: Enlil and Ensemble





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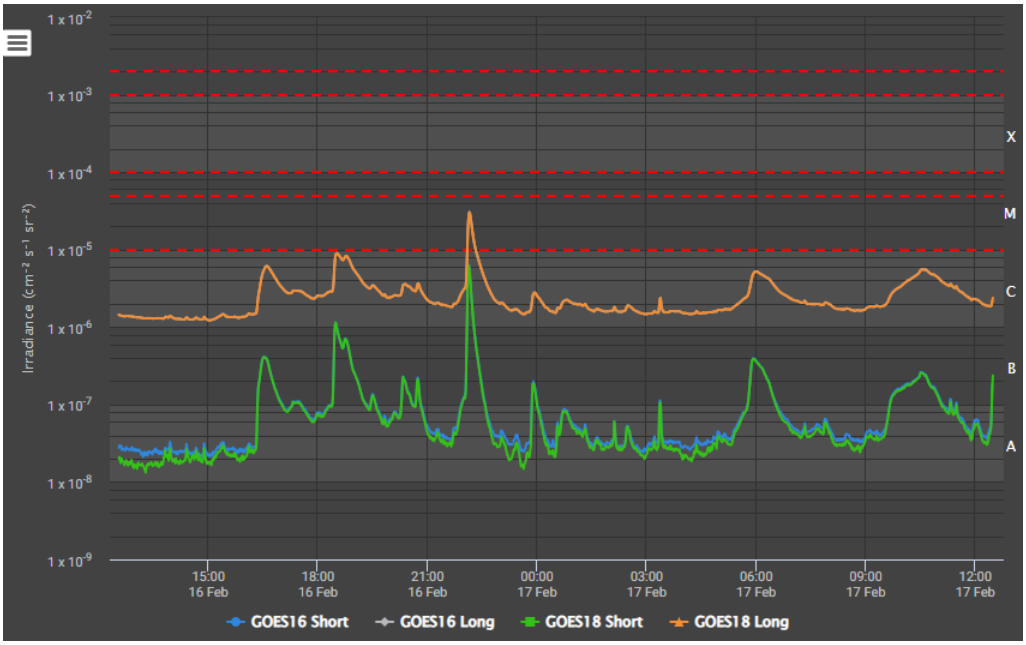
Radio Blackouts - X-Ray Flares:

Moderate to Low activity is forecast, with an ongoing chance of isolated M-flares. There remains a slight chance of an X-flare on day 1 (17 Feb), primarily from AR3576 which is now just over the southwest limb, however this risk recedes day 2 (18 Feb) onward with the other regions currently on the visible disc smaller and exhibiting less complexity.

AR3576 likely remains a large, magnetically complex sunspot region, with some significant looping still visible on e.g. SDO aia-171 and 304, and any notable flares have the potential to still be visible on the Earth-facing disc. Of the nine sunspot regions currently on the Earth-facing disc, AR3583 is the most developmental, with ongoing flux emergence around its leader leading the development of both small intermediate spots and a more complex magnetic configuration. However this remains a relatively mature and spread out group, and is also now moving towards the west limb.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	60	50	40	40
Very Active	R3 to R5 X Class	No	15	5	5	5

Figure 3: GOES-16/18 X-ray Flux



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Solar Radiation Storms - (High Energy Protons):

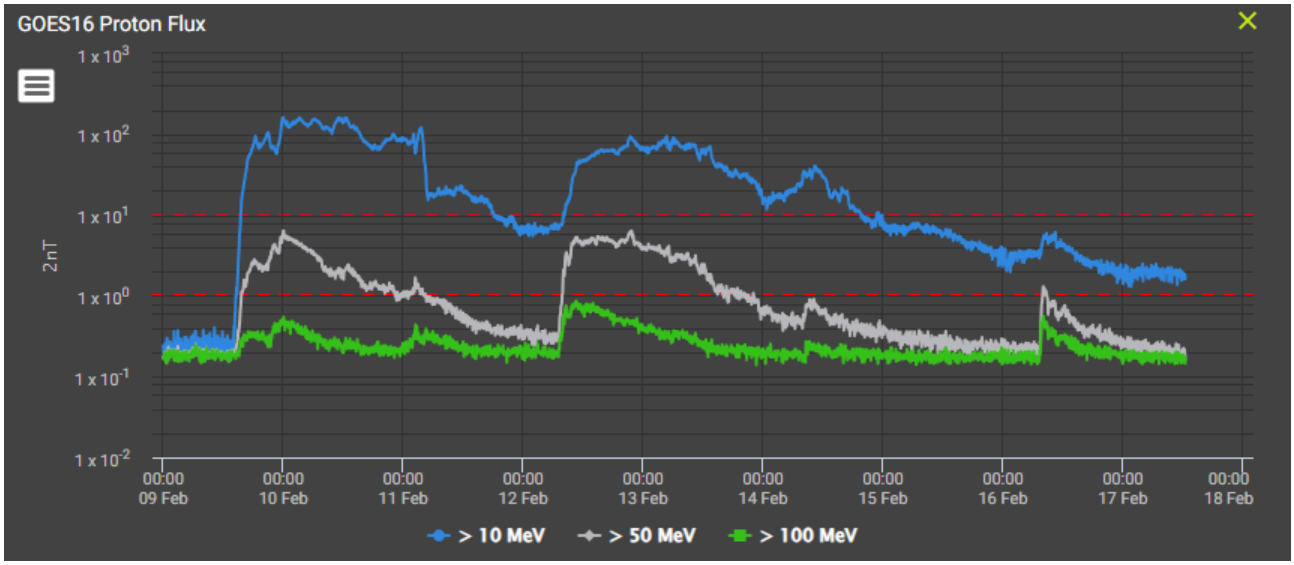
GOES 18 high energy (greater than 10MeV) protons remain above background, but below the S1 Minor Solar Radiation Storm level. This is due to the recent enhancements from the notable flare activity on the west limb, the most recent being from the X2.5 flare of AR3576.

This region will continue to be a risk for further proton enhancements as it moves onto the far-side, with the this potential only receding day 3 onward (19 Feb). The current sunspots on the Earth-facing disc have a lower chance of notable flares, and are currently considered unlikely sources of further proton events, unless further development occurs.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	10	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: GOES-18 Proton Flux >100MeV, >50MeV and >10 MeV since 09 Feb



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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) at GOES16 is expected to remain at background levels. There are no significant coronal hole fast wind enhancements expected, and any potential CME glancing blow on day 3 is likely to be weak. These are not expected to drive a significant increase in electron flux.

24-hour fluence values are expected to continue well below the Active (1e8 integrated pfu) threshold, as suggested by REFM.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^{8}$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	1	1

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